https://academo.org/demos/electric-field-line-simulator/

Electric Fields, E (not energy)
http://www.falstad.com/vector3de/

(gravitational field strength, g, is the force per unit mass $g=F/m = GM/r^2$ caused by a large mass)

uniform field universal

Electric field, E, is the force per unit charge
$E=F/q = kQ/r^2$

uniform field - parallel plates

around a single point Charge Q

Electric field lines show the direction of force on a small positive test charge, q

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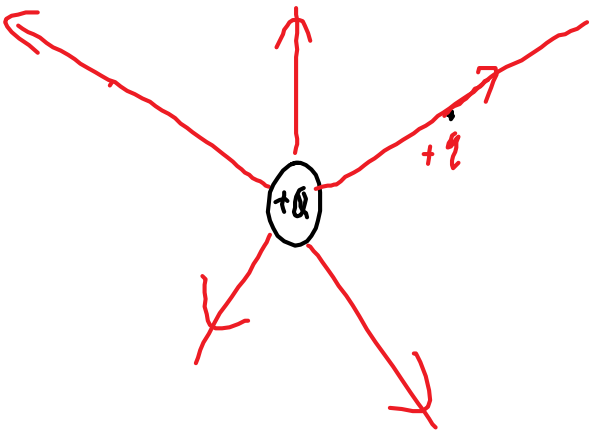
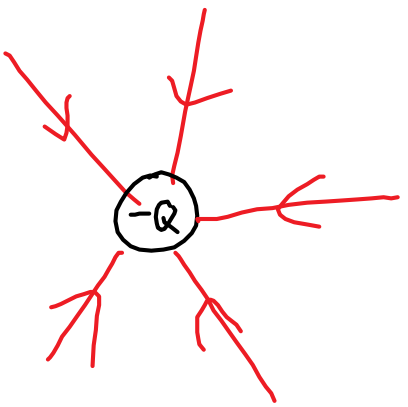


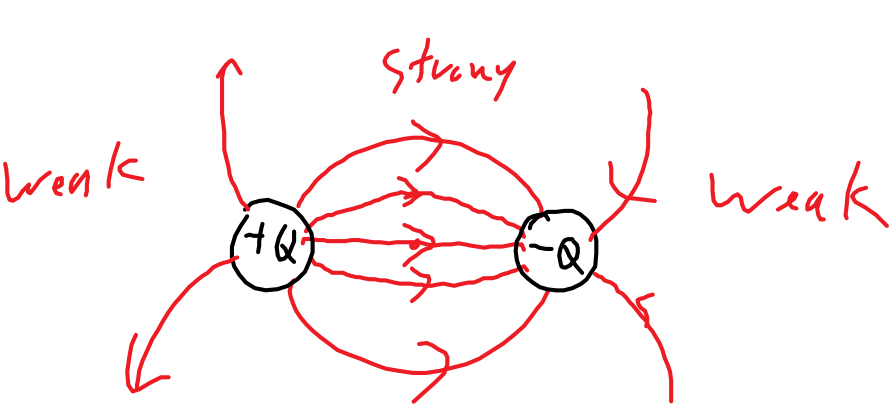
rules for field lines:

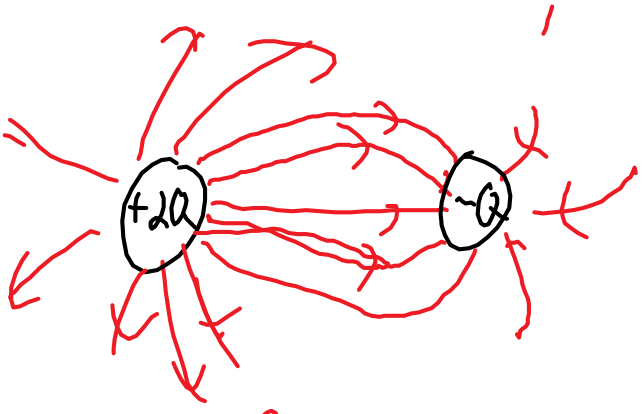
1. they never cross
2. they are perpendicular to the surface of a conductor
3. they are bunched where the electric field is stronger
4. go from positive to negative

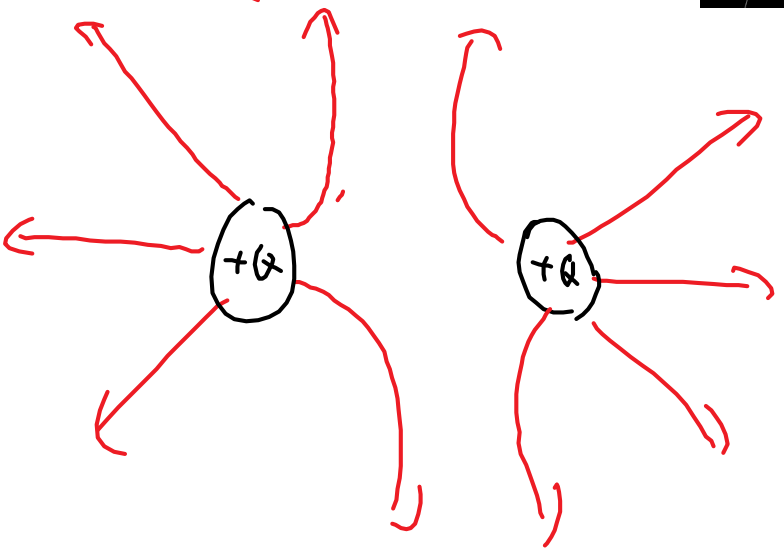


If there are two charges, you have to do vector

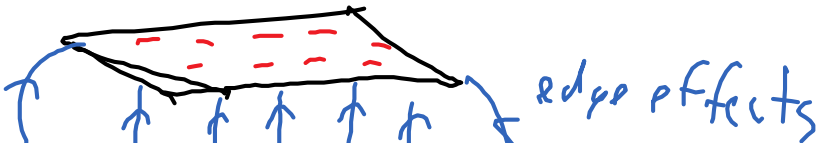
addition of the electric fields at each point.

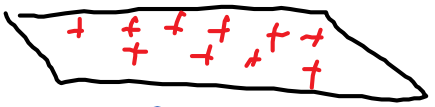






Parallel plates are conducting plates with charge, usually opposite charge.
Remember the field lines go from positive to negative.





E field is uniform between the plates

eg. 1. What is the electric field strength, in N/C, 5.0 x 10^{-11} m from a proton? Draw the field lines e=1.602x10^{-19}C

2. A 2.0 μC charge is 20.0 cm from a 4.0 μC charge.

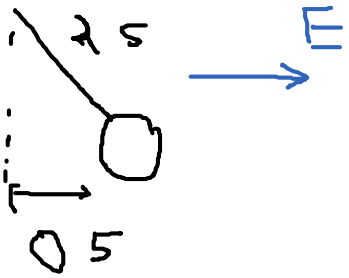
a) draw the field lines

b) What is the force between the charges?

c) What is the electric field strength and direction at the midpoint between the charges?

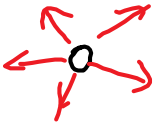
d) what is the electric field strength 5.0cm above the midpoint? (need cosine law)

3. A balloon has a mass of 20.0 g and hangs from a 2.50 m string. If the charge on the balloon is 3.0 μC and it gets deflected by 0.50m what is the electric field strength?



p438 Q 15-25 odds

What is the electric field strength, in N/C, 5.0 x 10^{-11} m from a proton? Draw the field lines e= 1.602x10^{-19}C

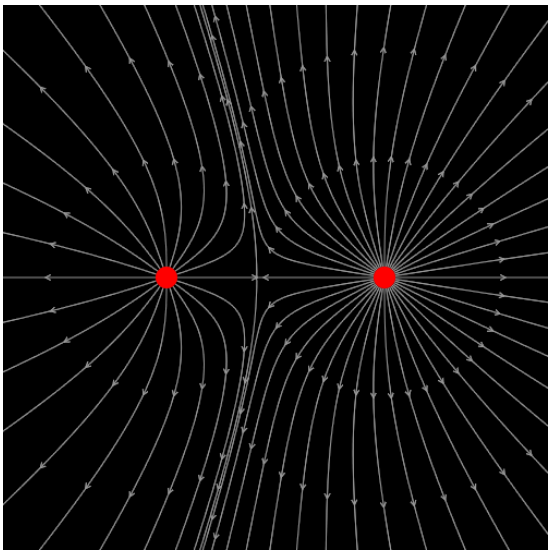


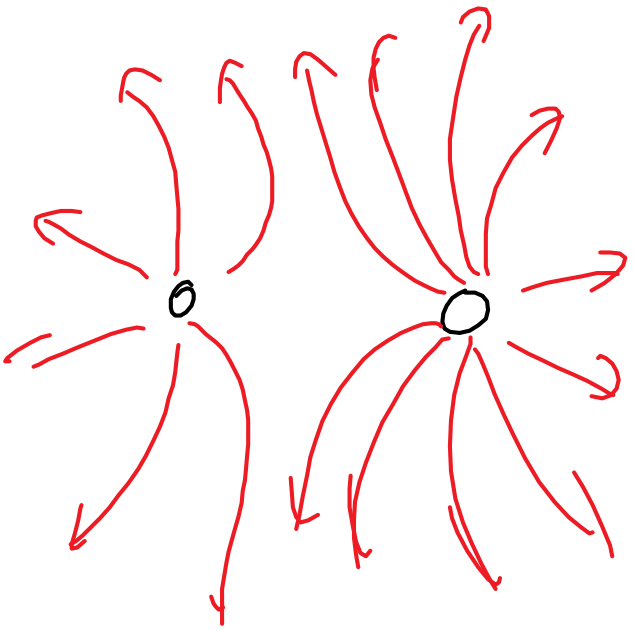
$E=kQ/r^2 = 9x10^9\ Nm^2/c^2(1.602x10^{-19}\ C)/(5x10^{-11})^2$

$E= 5.8 \times 10^{11} N/C$

2. A 2.0 μC charge is 20.0 cm from a 4.0 μC charge.

a) draw the field lines





b) What is the force between the charges?

$F=kQq/r^2 = 9x10^9(2x10^{-6})(4x10^{-6})/(0.20)^2$

$= 9x2x4/(0.2x0.2)=1,800.0$

1.8N

c) What is the electric field strength and direction at the midpoint between the charges?

$E=kQ_1/r^2 - kQ_2/r^2$ (vector addition)

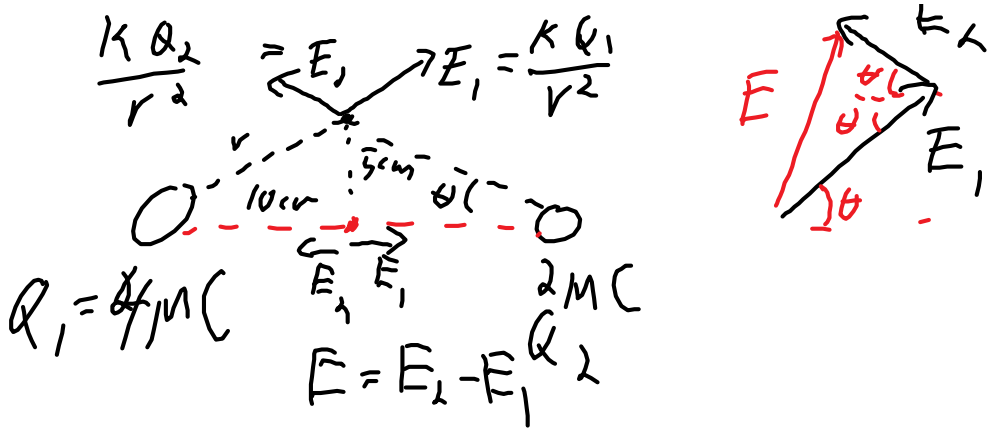
$= 9x10^9(4x10^{-6})/(0.10)^2 - 9x10^9(2x10^{-6})/(0.10)^2$

$(9x4/0.01)-(9x2/0.01)=1,800.0$

$1.8 x10^6$N/C towards the 2 μC charge

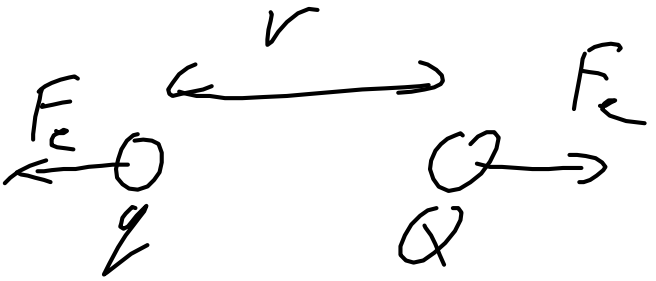
d) what is the electric field strength 5.0cm above the midpoint? (need cosine law)

$\frac{kQ_2}{r^2} = E_1 \quad E_1 = \frac{kQ_1}{r^2}$



a) A balloon has a mass of 20.0 g and hangs from a 2.50 m string. If the charge on the balloon is 3.0 μC and it gets deflected by 0.50m what is the electric field strength?

p437
Q11



$$F_e = \frac{kQq}{r^2} \qquad Q + q = Q_T$$

$$F_e = \frac{kQ(Q_T - Q)}{r^2}$$

$$F_e = \frac{kQQ_T - kQ^2}{}$$

$$F_e = C\left(Q_T Q - Q^2\right)$$

$$C\left(Q_T x - x^2\right)$$

$\uparrow$ 1.0

minimum when $x = Q_T$ or 0

$$\max x = \frac{Q_T}{2}$$

graph $x - x^2 = y$ max at 0.5

Q 7

$Q_1 + 70\mu C$ $\quad$ $Q_2 + 40\mu C$ $\quad$ $Q_3 - 80\mu C$

$$\frac{kQ_1Q_2}{r_{12}^2} \ominus \frac{kQ_1Q_3}{r_{13}^2}$$

Q 12

0 $\quad$ 0

+9mC $\quad$ −5mC

Electric Fields, E
(not energy!!!)

recall gravitational field strength, g
is the force per unit mass due to a large mass, M
$g=F/m = GM/r^2$ units: N/kg

non-uniform - around any planet/star

uniform
field
(like near Earth)

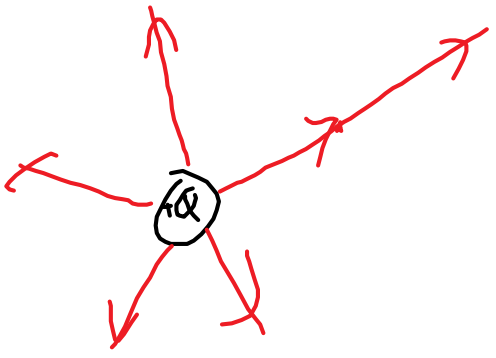
Electric Field strength, E is the force per unit charge, in N/C
$E=F/q = kQ/r^2$

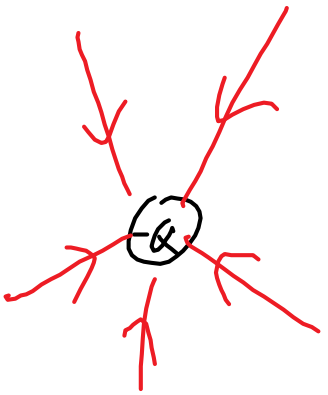
point charge, Q, or spherical charge

uniform
field

Like g, E is a vector

Electric field lines show the direction of force on a small positive test charge, q.





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http://www.falstad.com/vector3de/fullscreen.html